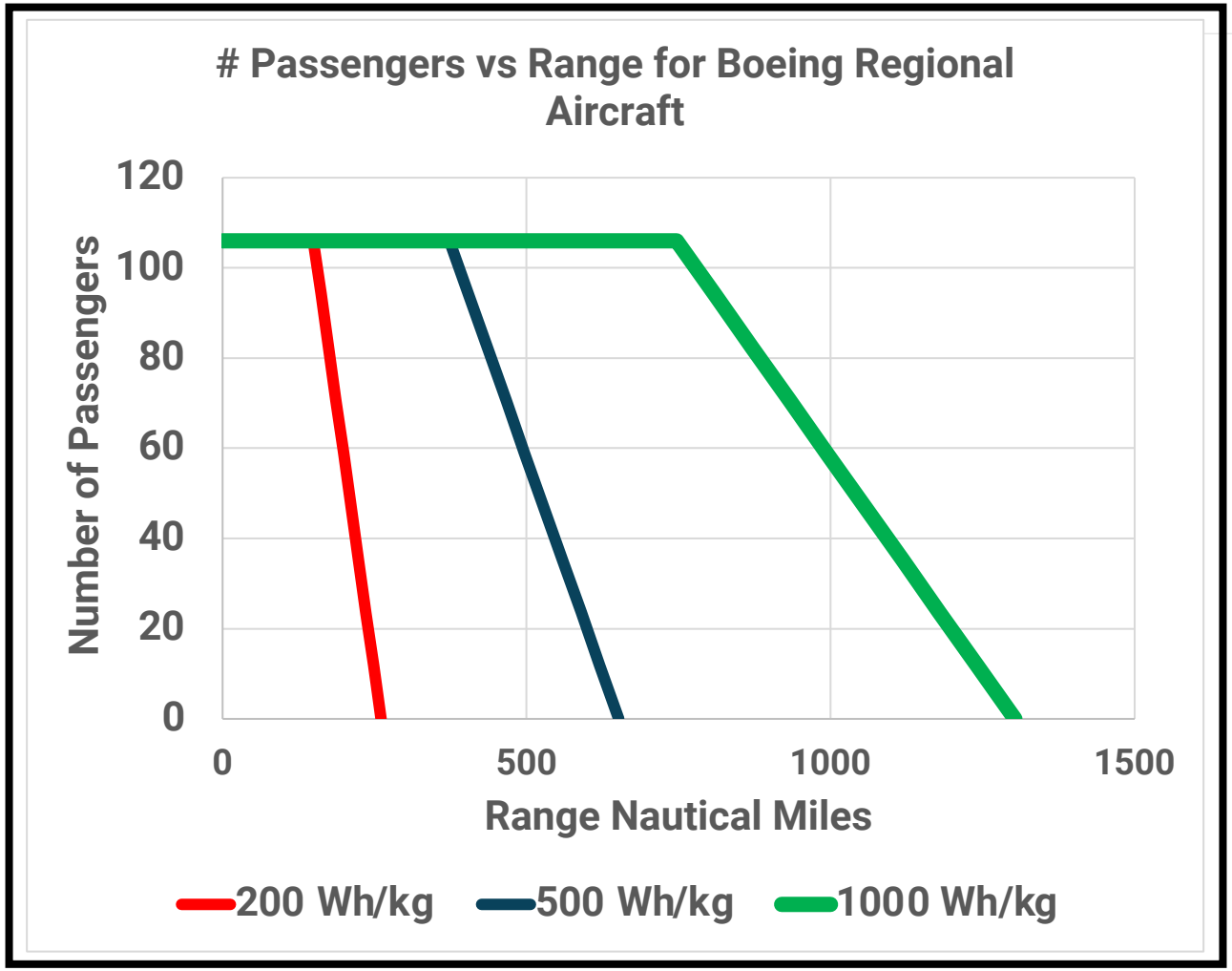
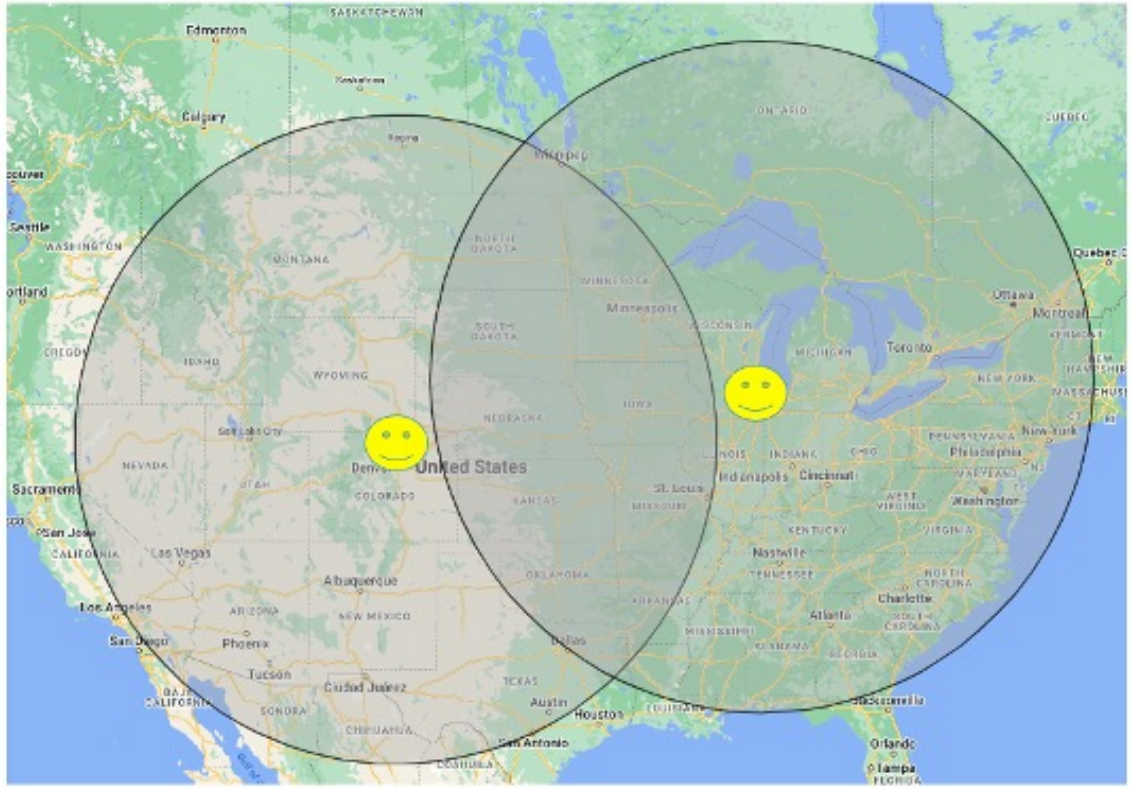
Battery 1K - The Electrification of Regional Flight

Dr. Halle Cheeseman

1,000 Wh/Kg makes regional jet electrification very possible



700 NM radius circles centered on Denver & Chicago



Assumptions: eta 83.7%, L/D = 25, Reserve = 19%

Total US Regional Aircraft CO_2 Emissions = 70 million tons/year

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Jet Fuels versus Battery Materials….an intriguing comparison

Jet Fuel 12kWh/Kg	Lithium 11.1kWh/Kg	Aluminum 8.4kWh/Kg	Magnesium 6.1kWh/Kg	Zinc 1.35kWh/Kg
				
0 Kg	Li_2O = 5.2kWh/Kg.	Al_2O_3= 4.3kWh/Kg	MgO = 2.8kWh/Kg	ZnO = 1.1kWh/Kg
1kWh/Kg vs Theoretical	19%	23%	36%	91%

How do we package these metals to deliver 1000Wh/Kg

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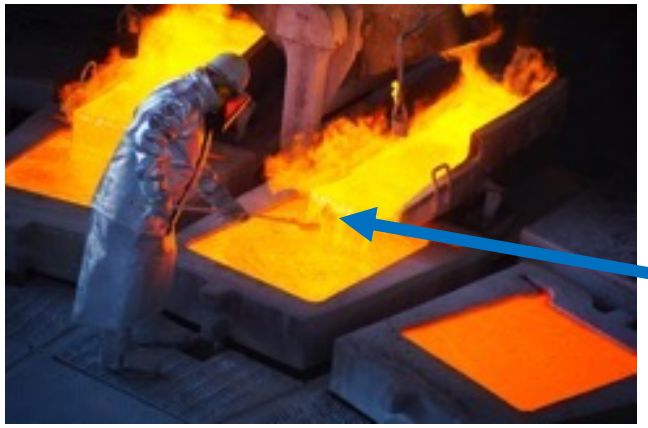
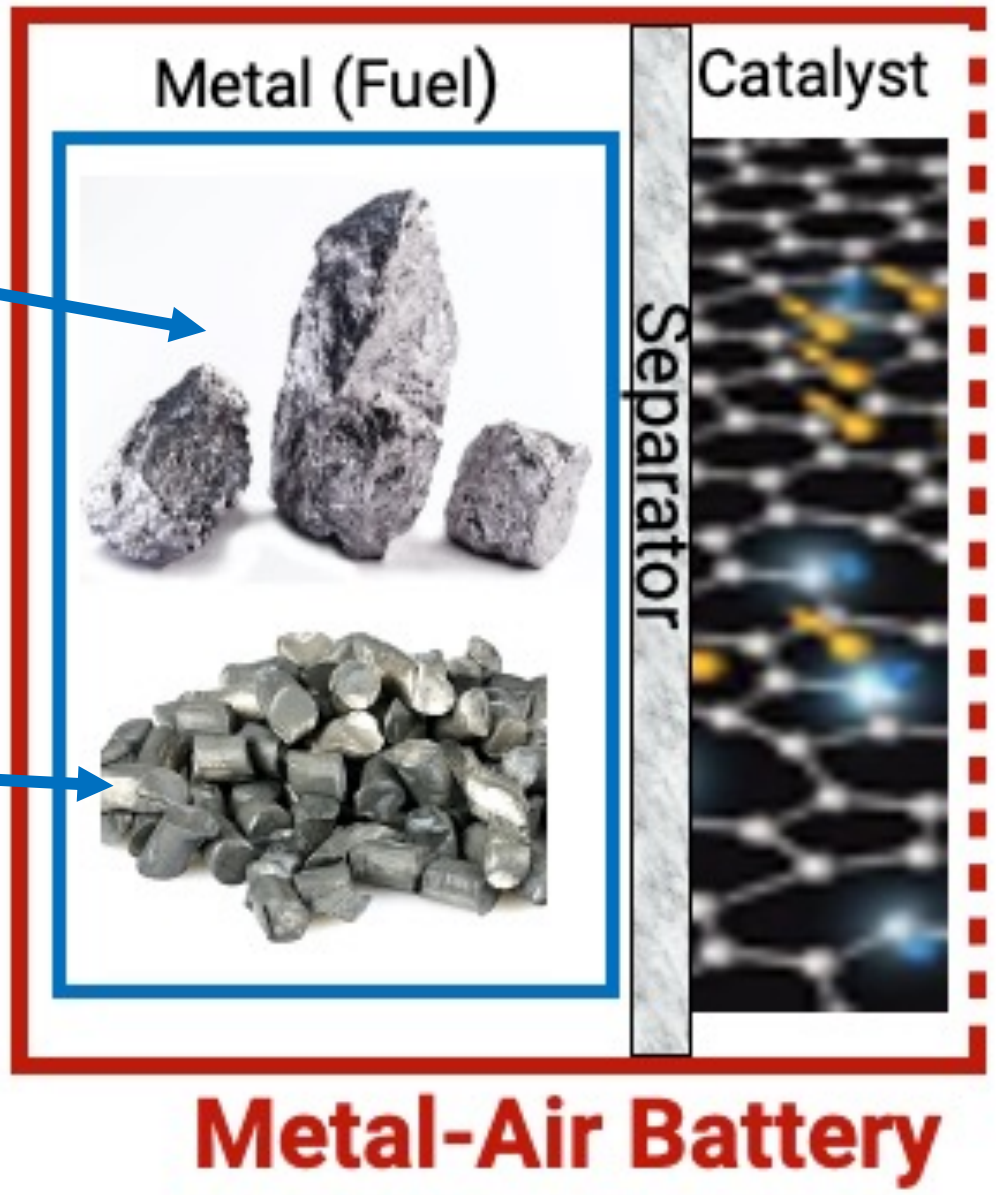
A Metal-Air Battery is one Possibility for 1kWh/kg



Metal Production

Charger



Air

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Zinc Air History - an eclectic history of applications

Hearing Aid

Electric Vehicles

278 days

Railways & Farms

Military – Communications

Energy Storage

Best Achievable Zinc Air Energy Density = 300Wh/Kg = 27% of theoretical

Achieving 27% of theoretical in a practical design!

- **Lithium Air @ 1,400Wh/Kg**
- **Aluminum Air @ 1,160Wh/Kg**
- **Magnesium Air @ 760Wh/Kg**

Ascending

1K2

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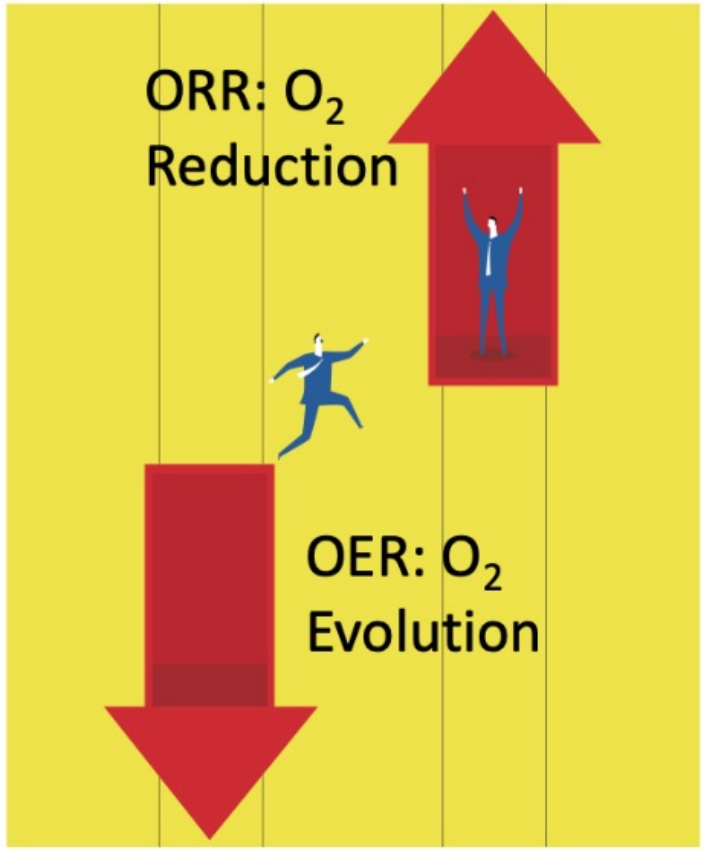
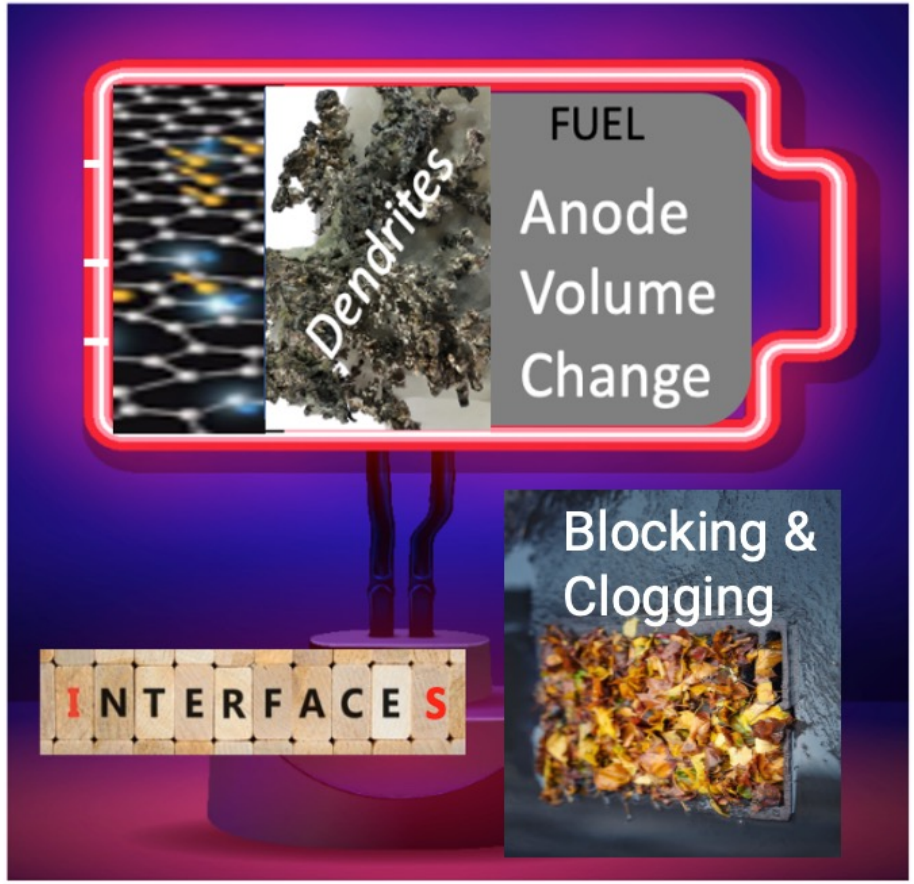
A Metal Air Battery has many problems to solve

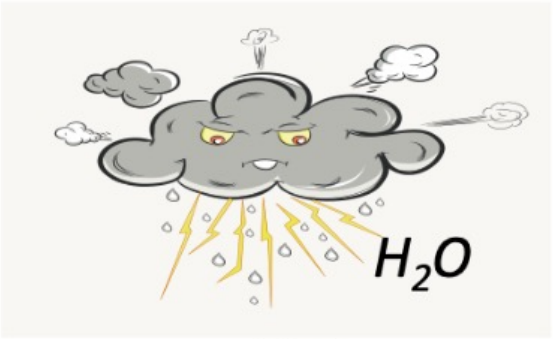
Cathode Reversibility & Efficiency

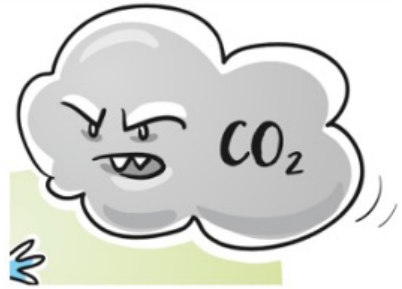


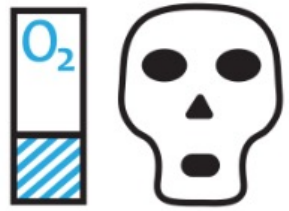
Anode Challenges



Contamination







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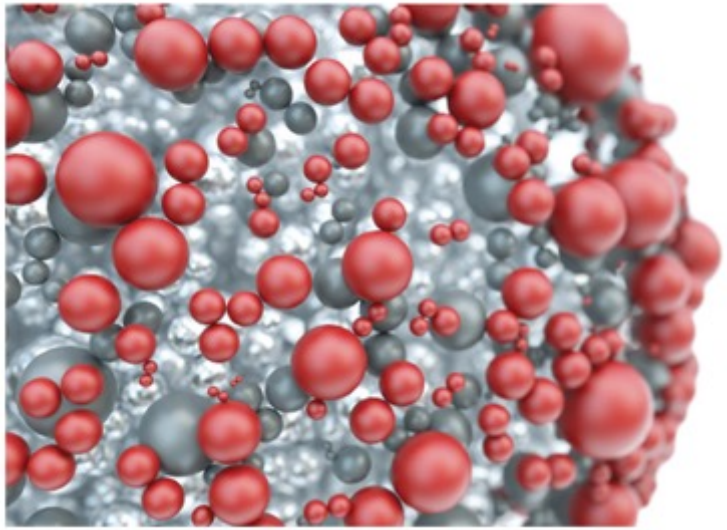
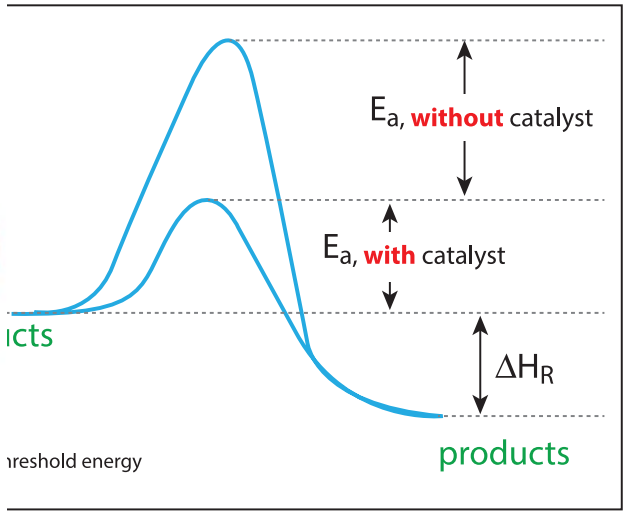
Bold Solutions - Catalysts & Electrochemistry

Electrochemistry

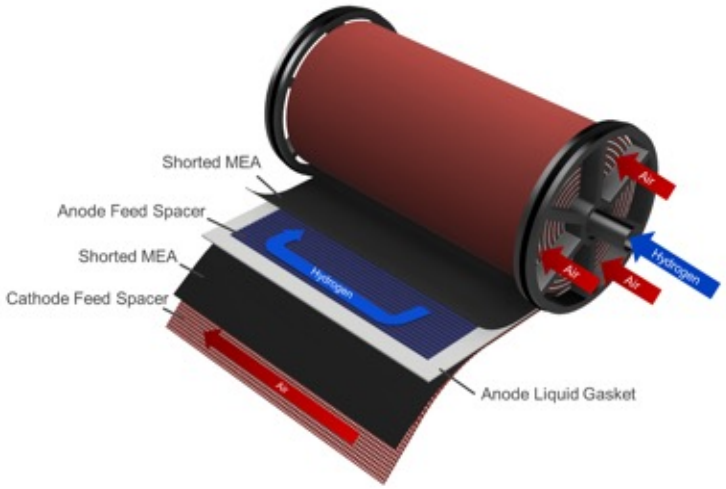
Catalysts Galore for ORR & OER

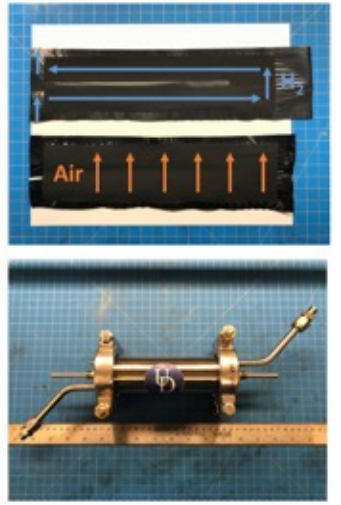




PGMs, Carbons, Transition Metals, TM Oxides……..

University of Delaware ECDS





Solutions for taking out CO_2

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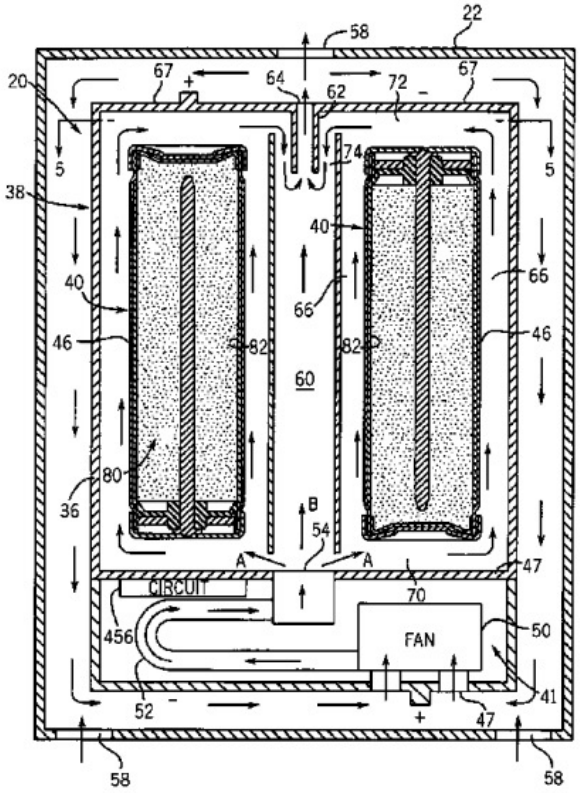
Bold Solutions - System Thinking & Trade-offs

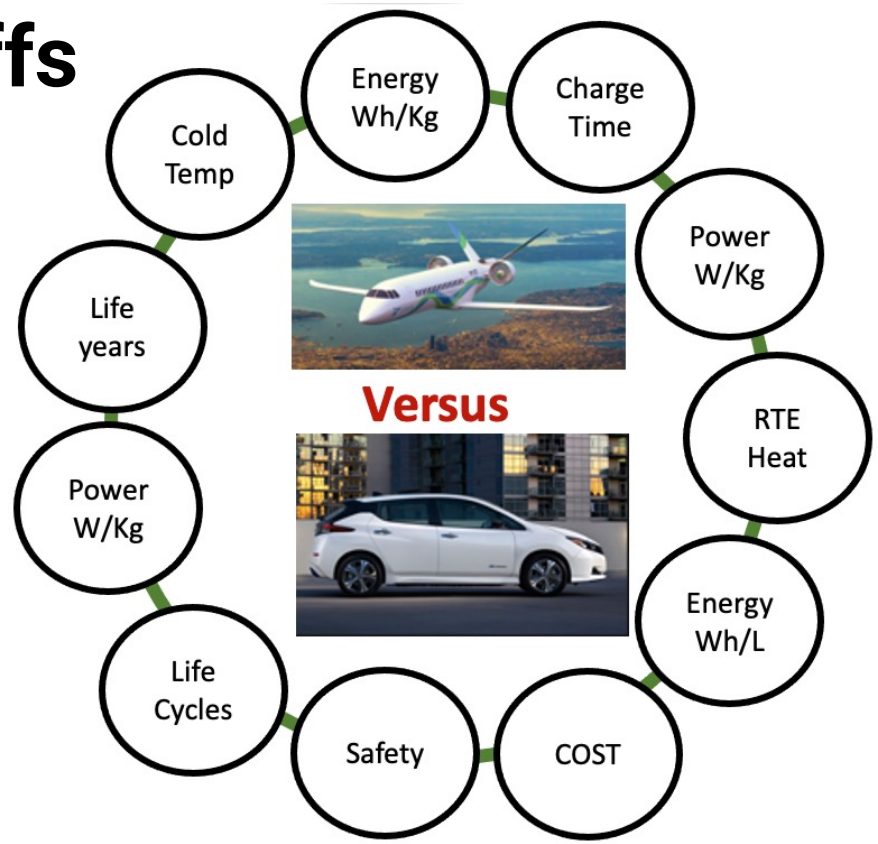
System Thinking

Air Manager

US 6,794,074 B2
Sep. 21, 2004



Trade-Offs



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What if we could crack the Holy Grail of Battery Systems?

➢ Lead Acid	20-40Wh/Kg
➢ Lithium Ion	100-300Wh/Kg
➢ Lithium Solid State	350-550Wh/Kg
➢ Battery 1K	1000Wh/Kg

Please, please contact us and lets discuss possibilities!

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